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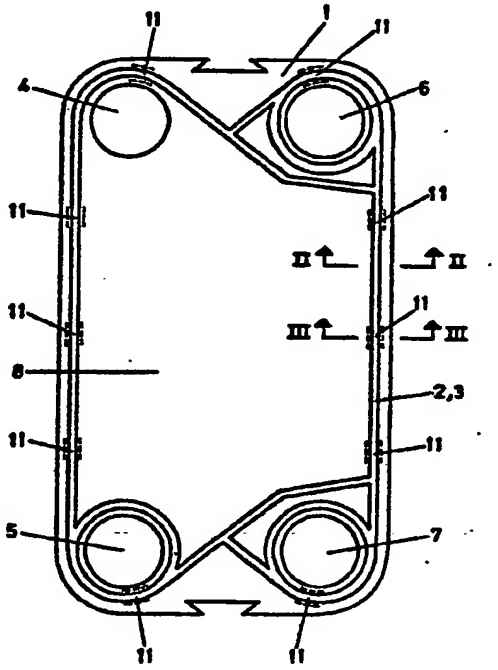
(57) Abstract

A heat exchanger sheet (1) with an appertaining packing (2) for use in heat exchangers of the kind in which extruded sheets of thin sheet material are stacked opposite to each other and held against each other between end covers, and where along the edges the sheets have at least one packing groove (3) pressed into the sheet for reception of a flexible packing (2) has been designed so that the side walls of the packing groove (3) below the edge of the groove are provided with a number of local recesses (11a or 11b) opening into the groove so that in the area of the recesses (11a or 11b) the clear opening of the packing groove (3) is wider than the opening of the packing groove (3). The packing (2) is shaped with projecting side parts (2a or 2b) fitting into the said recesses. The packing (2) can then be fixed in the groove by means of local engagements according to the press button principle.



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HEAT EXHANGE[redacted]HEET WITH AN APPERTAINING [redacted]KING

The invention relates to a heat exchanger sheet with an appertaining packing for use in heat exchangers of the kind in which extruded sheets of thin sheet material are stacked opposite to each other and held against each other between end covers, and where along the edges the sheets have at least one packing groove pressed into the sheet for reception of a flexible packing whereby flow channels are formed between the sheets for the media between which exchange of heat is to take place.

In heat exchangers of this kind the packings are fixed suitably in the packing groove so that they are placed securely when the heat exchanger is assembled and do not fall out when the heat exchanger is opened for inspection.

In order to produce such a fixation it is common when rubber packings are used to glue such packings to the packing groove. To this end, a glue has been used which ensures partly that the packing is secured and partly permits the packing to be removed relatively easily when it is necessary to replace packings. However, it is a disadvantage when packings are glued on that the adhesives which fix the packing and at the same time permit relatively easy replacement, become fluid at temperatures above 80°C and act as a kind of lubricant, thus creating a risk of the packing being ejected from the heat exchanger at high operating pressures. Besides, replacement of glued packings is time-consuming as the packing grooves have to be cleaned carefully of old glue before new packings can be glued on.

In order to avoid glueing of packings, sheets have been made for packings with a trapeziform profile, the bottom of the packing groove being wider than its opening. However, it is difficult to squeeze packings into such a trapeziform packing groove, and the process may require a special tool.

It has also been proposed to provide the edge sections of the packing groove with impressed bosses, cf. DK-PS 64107.

Impression of such bosses requires a complicated impression technique, and fixation of packings in this way is not acceptable for heat exchangers to be used for foodstuffs, e.g. milk, as in this way many corners accessible from the outside are formed in which impurities may accumulate.

The heat exchanger sheet according to the invention is characteristic in that the side walls of the packing groove below the edge of the groove are provided with a number of local recesses opening into the groove so that in the area of the recesses the clear opening of the packing groove is wider than the opening of the packing groove, and so that the packing is shaped with projecting side parts fitting into the said recesses.

The design of this heat exchanger sheet is based on the recognition that fixation of a packing in the packing groove of a heat exchanger sheet serves exclusively to hold the packing in position when the heat exchanger is assembled or opened for inspection. In other words: Fixation of the packing for this purpose along the entire length of the packing, such as is the case with prior art glueing or use of packings with a continuous trapeziform profile, has appeared to be unnecessary. When the packing has been placed in the groove, and the sheets in the heat exchanger have been clamped together, the friction between the packing and the sheets will be sufficient for the packing to be held in position even at high operating pressures.

It means that the disadvantages stated are avoided by using the invention. It is no longer necessary to use glue. The said local recesses made in the side walls of the packing groove interact with the projecting side parts of the packing according to press button principle whereby it becomes easy to place the packing in the groove. As the recesses are located below the edge of the groove, corners accessible from the outside are avoided in the area of the fixing parts, where impurities may otherwise accumulate.

According to the invention the recesses may have the form

of a spherical segment, or they may have the form of a cylinder surface ending in a hemispherical segment at either end. Such a design results in an easily manipulable fixation engagement. According to the invention it is expedient to place the recesses opposite to each other whereby fixation work becomes easy to control. Besides, the trapeziform can be used for fixation purposes as according to the invention opposed recesses may be designed in such a way as to impart a trapeziform cross section to the packing groove over a short distance.

It will be understood that the packing groove is provided with a suitable number of recesses and that the packing is provided with a suitable number of projecting side parts distributed along the lengths of groove and packing respectively.

The invention will be explained in detail in the following with reference to the drawing where

Fig. 1 shows a heat exchanger sheet according to the invention, viewed from the packing side,

Fig. 2 shows, on a larger scale, a section through the packing groove of the sheet along the line II-II in Fig. 1,

Fig. 3 shows, on a larger scale, a section along the line III-III in Fig. 1,

Fig. 4 shows a biased picture of the embodiment according to Fig. 3, with the packing shown separately,

Fig. 5 shows part of the sheet stack in a heat exchanger, viewed from one side as indicated by the arrow 13 in Fig. 2, and

Fig. 6 shows a changed embodiment of the stamped areas in the packing groove where the stamped area has the form of a spherical segment.

Fig. 1 shows a heat exchanger sheet 1 with a packing 2 placed in a packing groove 3. The sheet has corner holes 4, 5, 6 and 7 which are connected in pairs to the flow channels 8 of the heat exchanger which are formed in the spaces between adjacent sheets. In Fig. 1 the flow channel 8 is connected to the holes 4 and 5 while the neighbouring

channels on either side are connected to holes 6 and 7. The corner holes 4, 5, 6 and 7 form corner channels through the sheet stack when the sheets are stacked. One fluid to be heated or cooled may, for example, pass from corner channel 4 through flow channels 8 to corner channel 5, while the other fluid flows correspondingly through flow channels 8 from corner channel 7 to 6.

11 shows the localities where, in three places on both the long sides of the sheet, the packing groove has recesses in the form of stampings in the side walls of the groove for fixing of the packing.

Figs. 2 and 3 show packing grooves 3 with packings 2 for two adjacent sheets.

Fig. 2 shows a section along the line II-II in Fig. 1 through an ordinary section of the groove. The packing groove 3 and the packing 2 have the common rectangular profile shown. A corresponding section in Fig. 3 along the line III-III in Fig. 1 has been made at one of the localities 11 and shows that in this place packing 2 and packing groove 3 have been stamped locally to form a trapeziform cross section 11a; see also Fig. 4. Correspondingly, also the packing 2 has been provided locally with projecting side parts 2a. Parts 11a and 2a together constitute engagement according to the press button principle.

Fig. 6 shows, in a section corresponding to Fig. 3, an embodiment where the recesses in the side walls of the packing groove 3 are shaped as spherical segments 11b. The projecting side parts 2b of the packing 2 have a correspondingly curved shape 2b. Instead of being shaped as spherical segments the recesses 11b may be cylinder surfaces extending in the longitudinal direction of the groove, which surfaces end in hemispherical segments, and the projecting parts of the packing will then have the same embodiment.

As illustrated in both these embodiments, the recesses 11a or 11b are made in the side walls of the packing groove 3

below the edge 3a of the groove. It means that the groove edge 3a continues without interruption also at the recesses. So there will be an unbroken, continuous, tight top part, with the groove edge and packing in contact along the entire length of the packing groove.

On one side of the packing groove 3 the flow channel 8 is located between the sheets, while the outer edge of the sheet 1 is located on the other side. This outer edge has a corrugated form 9 which, as shown in Fig. 5, is shaped in such a way that the outer edges of a number of sheets bear against each other and support the outer side 10 of the packing groove 3. The result is that the heat exchanger can be used for high operating pressures without the outer side 10 of the packing groove 3 being forced outwards so that the packing 2 can be ejected.

It is difficult to stamp a sheet with a packing groove with a trapeziform profile and at the same time stamp such favourable corrugated forms 9 in the outer edge of the sheet as the material requirement for a trapeziform profile is higher than the material requirement for a rectangular profile. The corrugated form 9 generally prevents or limits inclusion of sheet material from the sheet edge in the packing groove. However, the use of the local, limited, stamped recesses according to the invention nevertheless makes it possible to fix the packing 2 in the packing groove 3 without difficulty and at the same time maintain the corrugated form 9 of the sheet edge so that sufficient stiffness is available for making e.g. a sheet heat exchanger with a sheet thickness of only 0.8 mm which can work at an operating pressure of 25 kp/cm^2, while the use of 1.1 mm sheet without the corrugated form only permits an operating pressure of 10 kp/cm^2.

Seen in the direction of the arrow 13 in Fig. 2, Fig. 5 shows part of the outer side of a heat exchanger where a short section of the three sheets 1a, 1b and 1c bear against each other along the sheet edge. The corrugated forms 9 of sheets 1a and 1c are offset half a wave width

relative to the corrugated form 9 of the sheet 1b so that the top of a wave of one sheet bears against the bottom of the wave of the adjacent sheet.

When the side walls of the packing groove 3 are stamped for formation of recesses with a trapeziform profile as shown in Fig. 3, it must be seen that the transitions to the rectangular profile, as shown in Fig. 2, are evened out by inclined or curved surfaces so that edges do not occur in the transitions. At the same time, the packing 2 is made in such a way that it fits accurately into the packing groove 3 everywhere and fills it completely.

The production of the localities 11 with recesses in the side walls of the packing groove can take place together with stamping and profiling of the sheet 1. It may, however, be preferred to stamp the sheet 1 first without localities 11 with stamped recesses in the 3 sides of the packing groove 3, and then to stamp the recesses in the side walls of the groove at the localities 11 in a subsequent operation. In this way, a simpler tool is obtained for the primary stamping of the sheet 1 and the secondary stamping of the localities 11 can be made with a single tool.

For certain purposes, packings of an unflexible material like e.g. teflon are used which cannot be pressed into a packing groove in the same way as a rubber packing. If the localities 11 are made by secondary stamping, the heat exchanger sheets can be stocked in a form which can be used for both unflexible packings, which are fixed by glueing, and non-glued rubber packings when the secondary stamping of the localities 11 has taken place.

In the above embodiment of heat exchanger sheets according to the invention, the packing groove 3 itself is shown with a rectangular profile. According to the invention a packing 2 can also be fixed in packing grooves with different profiles like e.g. a hemispherical profile or a profile with parallel sides and a curved or hemispherical bottom.

Heat exchangers of the type described here are made extensively of expensive sheet material e.g. acid-proof stainless steel and titanium. It is, therefore, important that the heat exchanger sheets should be made of as thin a sheet material as possible. The effect is twofold as the thin sheet also gives an increased heat transmission.

C L A I M S

1. A heat exchanger sheet with an appertaining packing for use in heat exchangers of the kind in which extruded sheets of thin sheet material are stacked opposite to each other and held against each other between end covers, and where along the edges the sheets have at least one packing groove pressed into the sheet for reception of a flexible packing, characterized in that the side walls of the packing groove (3) below the edge of the groove are provided with a number of local recesses (11a or 11b) opening into the groove so that in the area of the recesses the clear opening of the packing groove (3) is wider than the opening of the packing groove, and so that the packing (2) is shaped with projecting side parts (2a or 2b) fitting into the said recesses.

2. A heat exchanger sheet as claimed in claim 1, characterized in that the recesses (11b) have the shape of a spherical segment.

3. A heat exchanger sheet as claimed in claim 1, characterized in that the recesses are shaped as a cylinder surface extending in the longitudinal direction of the groove (3) and ending in hemispherical segments.

4. A heat exchanger sheet as claimed in claim 1, characterized in that the recesses (11a or 11b) are placed opposite to each other from side wall to side wall.

5. A heat exchanger plate as claimed in claim 4, characterized in that the opposed recesses (11a) are designed so as to impart a trapeziform cross section to the packing groove (Fig. 3).

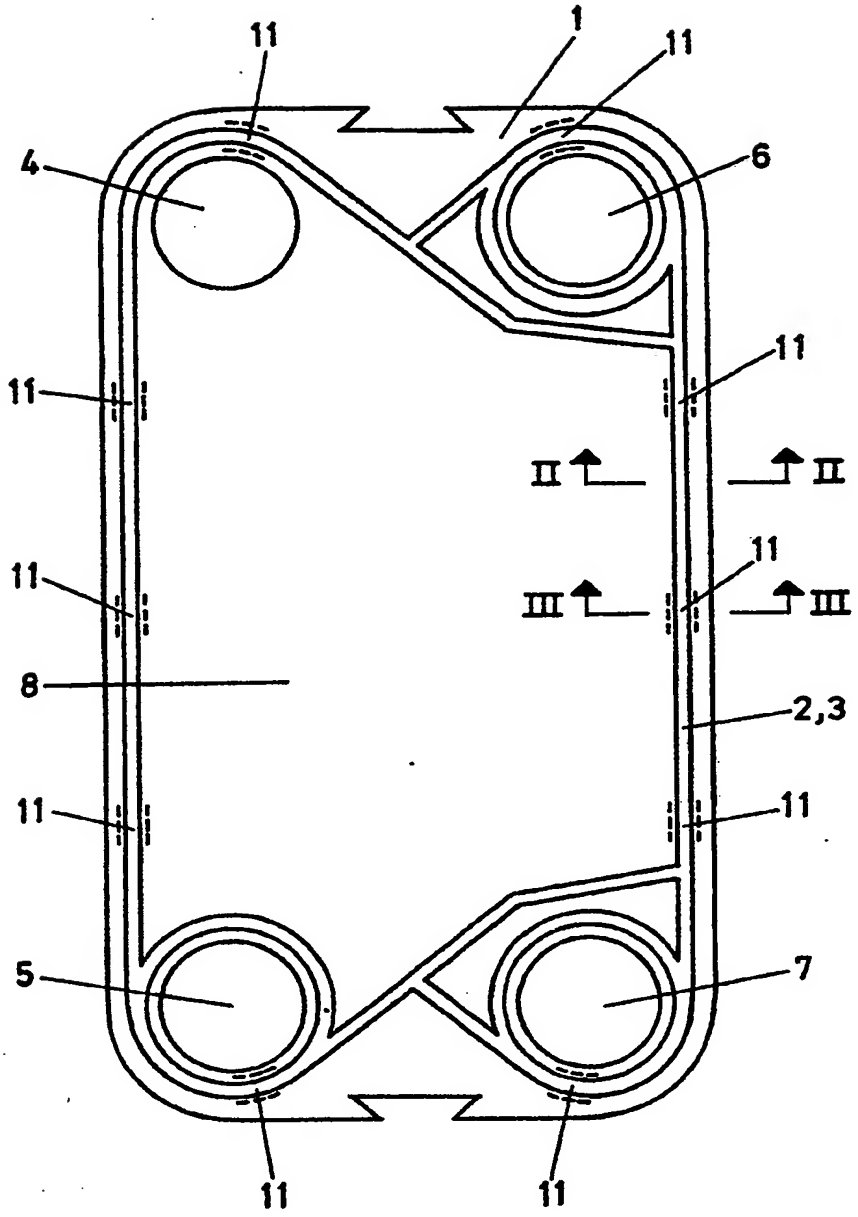

Fig. 1

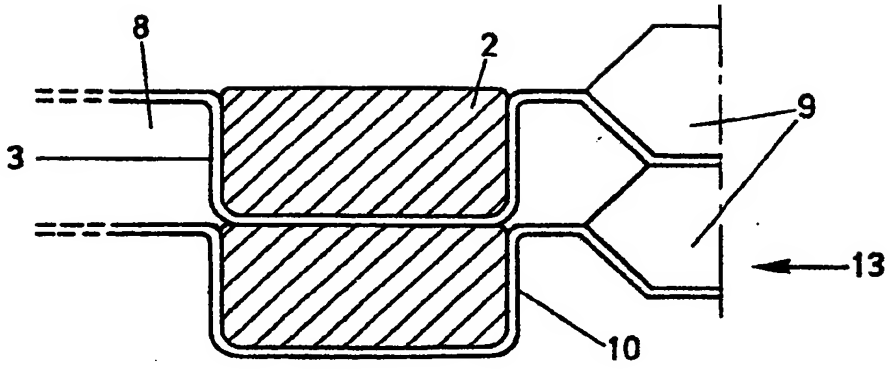

Fig. 2

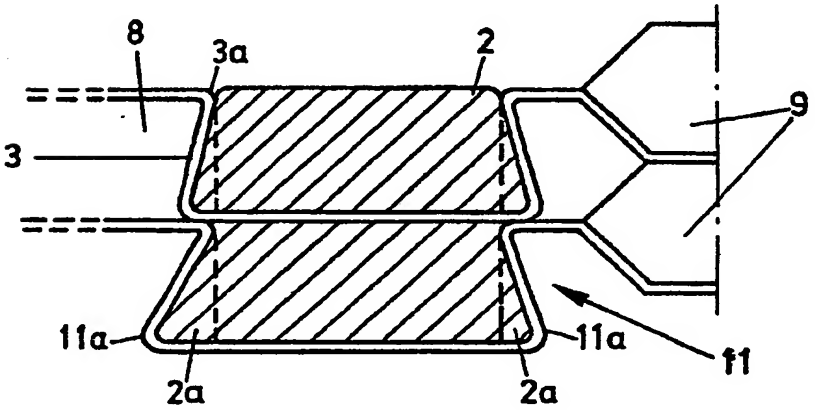

Fig. 3

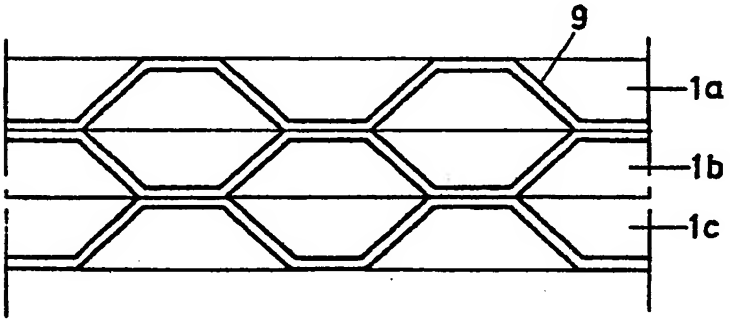

Fig. 5

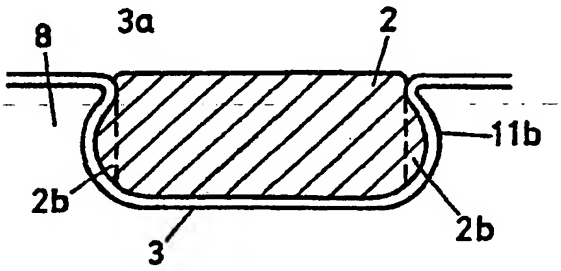

Fig. 6

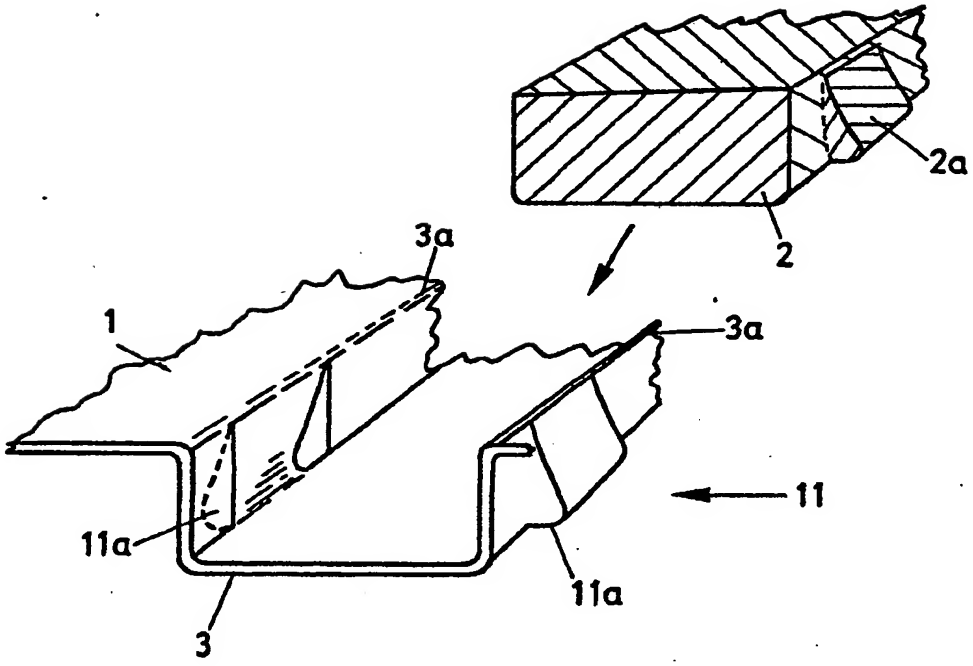

Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK85/00082

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC [4]

F 28 F 3/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 28 F 3/00, /08, /10; F 28 D 9/00
Nat Cl	17f: 5/30; 53e: 2
US Cl	165:165, 166, 167

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	SE, A, 116 638 (E D HANSEN) 25 June 1946	1,4
Y	WO, A1, 84/04809 (ALFA-LAVAL THERMAL AB) 6 December 1984 & EP, 0143838	1,5
Y	SE, A, 325 045 (THE A P V CO LTD) 1 July 1968	1,2,4
A	FR, A, 1 564 920 (DE DIETRCH & CO) 25 April 1969	

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IV. CERTIFICATION

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Swedish Patent Office	Heléne Eliasson

Form PCT/ISA/210 (second sheet) (January 1985)